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<b>(21) International Application Number:</b> PCT/FI98/00879 <b>(22) International Filing Date:</b> 11 November 1998 (11.11.98) <b>(30) Priority Data:</b> 974198 11 November 1997 (11.11.97) FI <b>(71) Applicant (for all designated States except US):</b> SONERA OY [FI/FI]; Sturenkatu 16, FIN-00510 Helsinki (FI). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> LAHTINEN, Pasi [FI/FI]; Aittatie 1 A 3, FIN-00390 Helsinki (FI). <b>(74) Agent:</b> PAPULA REIN LAHTELA OY; Fredrikinkatu 61 A, P.O. Box 981, FIN-00101 Helsinki (FI).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i>
<b>(54) Title:</b> GENERATION OF A SEED NUMBER  <b>(57) Abstract</b>  Method for computing the key to an encryption algorithm used to encrypt messages to be transmitted over a telecommunication network and for generating the seed number needed for the computation of the encryption key. According to the invention, the seed number used is a number computed from a random number generated by the authentication centre of the mobile communication network, and the encryption key is computed using the authentication algorithm from the seed number and a subscriber identification key.		

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## GENERATION OF A SEED NUMBER

The present invention relates to a method as defined in the preamble of claim 1 for computing the key to an encryption algorithm used to encrypt messages transmitted over a telecommunication network and for generating the seed number needed for the computation of the encryption key by making use of the subscriber identity module of a mobile station. Moreover, the invention relates to a system as defined in the preamble of claim 7 for computing the key to an encryption algorithm used to encrypt messages transmitted over a telecommunication network and for generating the seed number needed for the computation of the encryption key by making use of the subscriber identity module of a mobile station.

In the near future, it is to be expected that further applications will be designed for mobile station subscriber identity modules, such as SIM cards (Subscriber Identity Module, SIM), in which encryption of communication is required. The encryption algorithm implementing the encryption needs an encryption key. In prior art, a method is known in which a separate algorithm for computing the encryption key is implemented in the subscriber identity module of a mobile station. In another prior-art method, the encryption key is stored on the subscriber identity module in conjunction with manufacture. In yet another previously known method, the encryption key is stored on the subscriber identity module when the latter is taken into use. A problem with the prior-art methods is that managing the seed number needed for the computation of the encryption key and/or managing the encryption key is difficult and, e.g. in solutions based on an RSA algorithm, separate equipment is needed. A further problem is that an encryption key permanently stored on the subscriber identity module is not as secure as an encryption key having a variable value.

The object of the present invention is to disclose a new type of method that eliminates the problems described above. A further object of the invention is to disclose a system that can be used to implement  
5 said method.

A specific object of the present invention is to disclose a method and a system that allow flexible and safe management of seed numbers and encryption keys.

10 As for the features characteristic of the present invention, reference is made to the claims.

In the method of the invention, the encryption key required by the encryption algorithm used for the encryption of communication is computed from a certain  
15 seed number by making use of the subscriber identity module of the mobile station. When the mobile station is activated, its subscriber identity module performs an authentication procedure with the mobile communication network. This is done by using an operator-specific authentication algorithm and a seed number  
20 consisting of a random number RAND generated by the mobile communication network. The same authentication algorithm can be used to compute an encryption key. The seed number is a number computed on the basis of a random number RAND generated by the authentication centre  
25 AC of the mobile communication network. Using the seed number and a subscriber identification key  $K_i$  as starting values for the authentication algorithm, an application in the subscriber identity module computes the encryption key and stores it in the subscriber identity  
30 module. This encryption key is used when messages are to be encrypted and/or decrypted.

As compared with prior art, the present invention has the advantage that it makes the management of  
35 seed numbers and encryption keys considerably easier and simpler than before. As the seed numbers and encryption keys are calculated in the subscriber identity module when necessary, they need not be transmitted or

set. A further advantage is that no separate equipment is needed for the management of seed numbers and encryption keys, which means that cost savings are achieved. The invention also increases security. In the method of the invention, the encryption key changes continuously and it is not transmitted anywhere, thus considerably reducing the chance of its getting into the hands of outsiders.

In an embodiment of the method, a seed number is calculated from a random number RAND generated by the authentication centre, producing a seed number such as  $RAND+1$ .

In an embodiment of the method, the encryption key is computed by using an A3 algorithm, which is an operator-specific authentication algorithm.

In an embodiment of the method, one or more encryption keys are used. In this case, each application requiring encryption has its own encryption key, thus increasing security.

In an embodiment of the method, the encryption key is computed by using one or more successive algorithms so that the result of the preceding algorithm is used as the seed number for the next algorithm. This provides the advantage that the seed number for the new algorithm is changed, which leads to increased security.

In an embodiment of the method, a certain portion of the random number range used by the mobile communication network is reserved for the calculation of seed numbers.

The system of the invention for computing the key to an encryption algorithm used to encrypt messages transmitted over a telecommunication network and for generating the seed number needed for the computation of the encryption key by making use of the subscriber identity module of a mobile station comprises an encryption device and means for the transmission of encrypted messages. The encryption device comprises a me-

ans for computing an encryption key from a seed number. The means used to transmit encrypted messages comprise a mobile station and an encryption server.

5 In an embodiment of the system, an encryption device is implemented both in the subscriber identity module and in the authentication centre.

In an embodiment of the system, the encryption device comprises a device for storing the encryption key.

10 In an embodiment of the system, the mobile station is GSM compatible.

In the following, the invention will be described by the aid of an embodiment example by referring to the attached drawings, wherein

15 Fig. 1a and 1b illustrate an example representing the method of the invention in the form of logic diagrams; and

Fig. 2 presents an example representing the hardware configuration of the system of the invention.

20 Fig. 1a illustrates a method in which the mobile communication network generates a random number RAND and sends it to the subscriber identity module 9. Based on this random number, a seed number RAND+1 is calculated. This seed number 1 and the identification  
25 key  $K_i$  2 are input as starting values to an A3 algorithm 3. The identification key  $K_i$  2 is a user-specific secret parameter, which has been stored in the subscriber identity module 9 and in the authentication centre 10. The A3 algorithm 3 is the same operator-specific  
30 algorithm that is used when the subscriber identity module 9 carries out an authentication procedure with the authentication centre 10 of the mobile communication network upon activation of the mobile station 8. A feature characteristic of the A3 algorithm 3 is that com-  
35 puting the encryption key 4 from the seed number 1 and the identification key  $K_i$  2 is easy, but determining the identification key 2 on the basis of the seed number 1 and the encryption key 4 is extremely difficult.

The encryption key 4 is the result produced by the algorithm 3. This encryption key 4 is used when messages are to be encrypted and/or decrypted.

Fig. 1b illustrates a variation of the method of the previous example. In this case, it is assumed that the random number range is 0 - 10000. It is divided into two halves so that the random number RAND values 0 - 4999 are reserved for the computation of seed numbers 5. the mobile communication network generates a random number RAND and sends it to the subscriber identity module 9. Based on the random number, a seed number  $RAND+5000$  is calculated. The seed number 5 and the identification key  $K_i$  2 are input as starting values to the A3 algorithm 3, which produces a new seed number 6 as a result. The new seed number 6 thus computed and the identification key  $K_i$  2 are given as starting values to a new algorithm 7. The result obtained is used as the final encryption key 4. The advantage provided by this alternative is that the seed number 6 for the new algorithm 7 is automatically changed.

Fig. 2 illustrates a system in which encrypted short messages are transmitted between a GSM telephone 8 and an encryption server 12 in a GSM network. An encryption device 11 has been implemented both in the subscriber identity module 9 of the mobile station 8 and in the authentication 10 of the GSM network. The encryption device 11 comprises a SIM Application Toolkit, an application that computes the encryption key 4. In addition, the encryption device 11 stores the computed encryption key 4 for use. When messages to be encrypted and/or decrypted are transmitted, the encryption device 11 computes an encryption key 4 on the basis of a seed number 1 and a user-specific identification key  $K_i$  2 both on the SIM card 9 and in the authentication centre 10. Based on this encryption key 4, an encryption algorithm, such as an RSA or 3DES algorithm, implemented both on the SIM card and in the authentication server 12, encrypts/decrypts the message. The key

4 is stored for the next time it is needed, or a new value for the key is computed each time.

The invention is not restricted to the examples of its embodiments described above, but many variations are possible within the scope of the inventive idea defined by the claims.



## CLAIMS

1. Method for computing the key (4) to an encryption algorithm used to encrypt messages to be transmitted over a telecommunication network and for  
5 generating the seed number (1, 5) needed for the computation of the encryption key (4) by making use of the subscriber identity module (9) of a mobile station (8), in which method the key to the encryption algorithm is computed from the seed number (1, 5) using a certain  
10 algorithm (3, 7), characterised in that

- the seed number (1, 5) used is a number computed from a random number RAND generated by the authentication centre (AC) (19) of the mobile communication network; and

15 - using the authentication algorithm (3) of the mobile communication network, the encryption key (4) required by the encryption algorithm is computed from the seed number (1, 5) and a subscriber identification key  $K_i$  (2).

20 2. Method as defined in claim 1, characterised in that the seed number is calculated from the random number RAND generated by the authentication centre (10), producing a seed number such as  $RAND+1$ .

25 3. Method as defined in claim 1 or 2, characterised in that the encryption key (4) is computed by using an A3 algorithm (3).

4. Method as defined in any one of claims 1 - 3, characterised in that one or more encryption keys are used.

30 5. Method as defined in any one of claims 1 - 4, characterised in that the encryption key is computed by using one or more successive algorithms (3, 7) in such manner that the result of the preceding algorithm (3) is used as the seed number for the next  
35 algorithm (7).

6. Method as defined in any one of claims 1 - 5, characterised in that a certain portion of

the random number range used by the mobile communication network is reserved for the computation of seed numbers (1, 5).

7. System for computing the key (4) to an encryption algorithm used to encrypt messages to be transmitted over a telecommunication network and for generating the seed number (1, 5) needed for the computation of the encryption key by making use of the subscriber identity module (9) of a mobile station (8), said system comprising an encryption device (11) and means (8, 12) for the transmission of encrypted messages, characterised in that

- the encryption device (11) comprises a means for computing the encryption key (4) from the seed number (1, 5); and
- the means used to transmit encrypted messages comprise a mobile station (8) and an encryption server (12).

8. System as defined in claim 7, characterised in that an encryption device (11) is implemented both in the subscriber identity module (9) and in the authentication centre (10).

9. System as defined in claim 7 or 8, characterised in that the encryption device (11) comprises a device for storing the encryption key (4).

10. System as defined in any one of claims 7 - 9, characterised in that the mobile station (8) is GSM compatible.

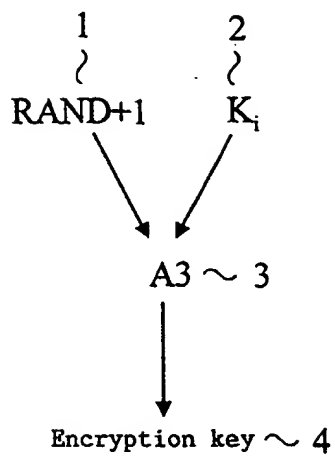


Fig. 1a

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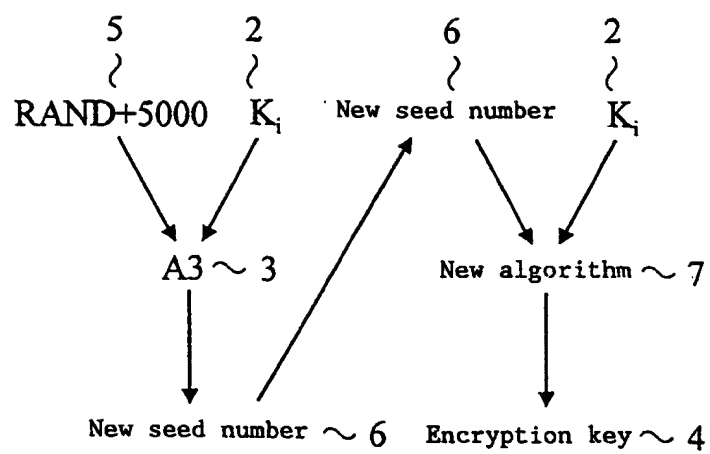


Fig. 1b

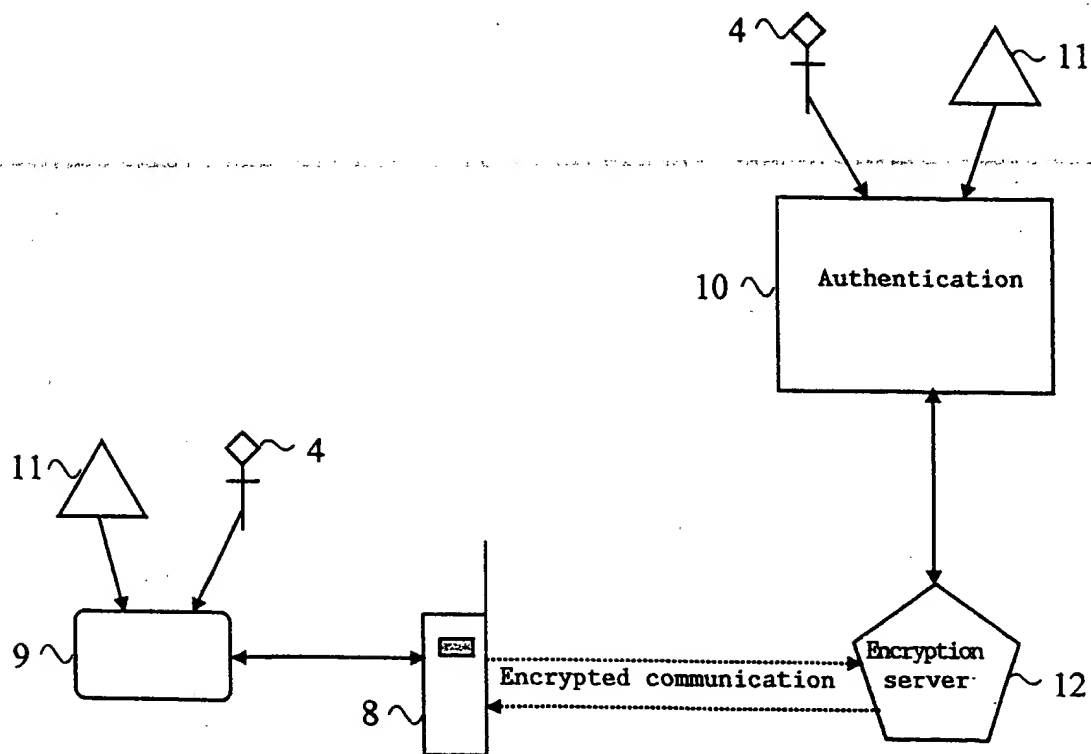


Fig. 2